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2 June 1980

East Europe Report

SCIENTIFIC AFFAIRS

(FOUO 5/80)

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EAST EUROPE REPORT

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CZECHOSLOVAKIA

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USE OF DECISION TABLES FOR PROTECTION OF DATA IN COMPUTERS AND DATA BANKS

Prague AUTOMATIZACE in Czech No 2, Feb 80 pp 40-43

[Article by Engr Cestmir Srajhans, CSc, College of the National Security Corps, Prague]

[Text] The article discusses the problem of protecting data in computers and data banks. The decision algorithm in automatic protection systems is fairly complex. The decision table is a suitable tool for the solution of this demanding problem. If the protection system is suitably designed, then the computer automatically puts into effect measures commensurate with the degree of threat to the stored or processed data. The article presents one of the feasible variants for designing data protection. Topic tags: data protection, decision tables.

Introduction

Advances in computer technology and the constantly growing volume of data stored and processed in computers and data banks create various problems. One such problem is effective and preferably automatic protection of the data from destruction, tampering, theft or misuse by an unauthorized person. If we disregard natural hazards (fires, earthquakes, floods, etc.), then the main threat to data security is man--the penetrator. By this concept we mean the organization or individual who intentionally or accidentally enters the system and by his action causes the data to be destroyed, distorted or stolen, to the user's detriment.

Indentifier's Role

The protection of data from penetration thus consists essentially of identifying the persons who have authorized access to the data, and of accurately defining the rights and privileges of these authorized persons. The various types of protection must therefore permit the differentiation of the individual users as authorized or unauthorized. An authorized user may have the following rights:

To alter the recorded data;
To read the data;
To exercise his privileges that may be full or limited;
To enjoy a certain priority in relation to other users.

If a user wants to access the system (computer or data bank), he first must prove that he is an authorized person, and that he performs activities and requires services only for which he has authorization. As soon as he exceeds his authority, he becomes an unauthorized person. The protection system then must immediately react, adopt the necessary measures and uncover the unauthorized activity. The agreed-upon and unambiguously defined method that is able to identify the user and to define his privileges is called the identifier. If the protection system is to be effective, it is not enough to identify merely the user. It is also necessary to unambiguously identify further elements of the system. Such elements are particularly:

Hardware elements:	terminals, processors, memories, telecommunications channels;
Software elements:	programs, sets, elements of the operating system;
Privileges:	priorities, authorization of activity in the system, secrecy classification.

Decision Tables

From the preceding it is evedient that it is by no means easy to decide whether a user is an authorized person, and whether he conducts only activities for which he is authorized. A decision matrix that could describe this situation would have to be multidimensional and very complex. Therefore it seems expedient to describe the decision algorithm with the help of decision tables. Decision tables are a suitable and by now well-developed tool, understable to both the computer and to man. Depending on the number of conditions, decision tables may contain scores and even hundreds of possible rules. The total number of all rules p is given by the equation:

$$p = 2^q$$

where q is the number of conditions. In the case of three conditions, then, we get eight different rules. If there are five conditions, the number of different rules is 32; and in the case of 10 conditions, their number is 1024. In such complex decision tables, many different rules lead to the same decisions. We then say that the decision table is redundant. It then becomes necessary to reduce the decision table and to exclude the redundant rules. When complex decision tables are being reduced, it may easily happen that some of the basic rules are omitted. If a decision table does not contain all the rules that lead to different decisions, we say that the decision table is incomplete. Combinations of the conditions from which the rules are formed may lead in some instances to contradictory situations in which it is not possible to make any decision. If the decision table contains such rules, we say that the table is contradictory (conflicting).

If the computer is to make correct decisions automatically on the basis of the adopted decision table, this table must be complete and nonredundant, and it must not contain contradictory rules. When constructing a decision table, therefore, it is essential to always check the table, correcting it when necessary.

During the logical analysis of the individual rules we often find that some of the conditions do not participate in the resultant decision; whether or not the conditions is met does not influence the decision. In such cases it is expedient to introduce in the quadrant of rules the so-called inconsistent value N. It indicates that the condition does not participate in the decision; thus for N we may substitute a value of 1 as well as a value of 0. In certain types of decision tables it is convenient to introduce the ELSE rule. These are tables that lead only to two different decisions and employ the logic function AND or OR. In decision tables of this type only one rule results in a certain decision, and all the other rules result in the opposite decision. Such a table is thus highly redundant. We remove the redundancy by retaining only the one rule and combining all the other rules into a single rule, the so-called ELSE rule. A decision table that contains an ELSE rule is complete and nonredundant.

Design of an Automatic Protection System

Figure 1 is a flowchart in which the decision algorithm of one of the possible systems for protecting data in computers or data banks is written with the help of decision tables. It is of course possible to write a single decision table for this purpose, but such a table would be too complex. Therefore three decision tables have been used: RT-1 (permission), RT-2 (execution), and RT-3 (verification). Let us now describe the mentioned flowchart, check the individual decision tables and analyze their logic.

When accessing the system the user must identify himself with valid identifiers. The first decision must be made, illustrated in the flowchart by the diamond "Access procedures fulfilled." If the user does not know the valid identifiers or makes a mistake during identification, he is rejected and warned that he did not proceed properly. The concept "access procedures" may include:

Identification of the user,
Identification of the terminal,
Identification of the processor, memory or channel.

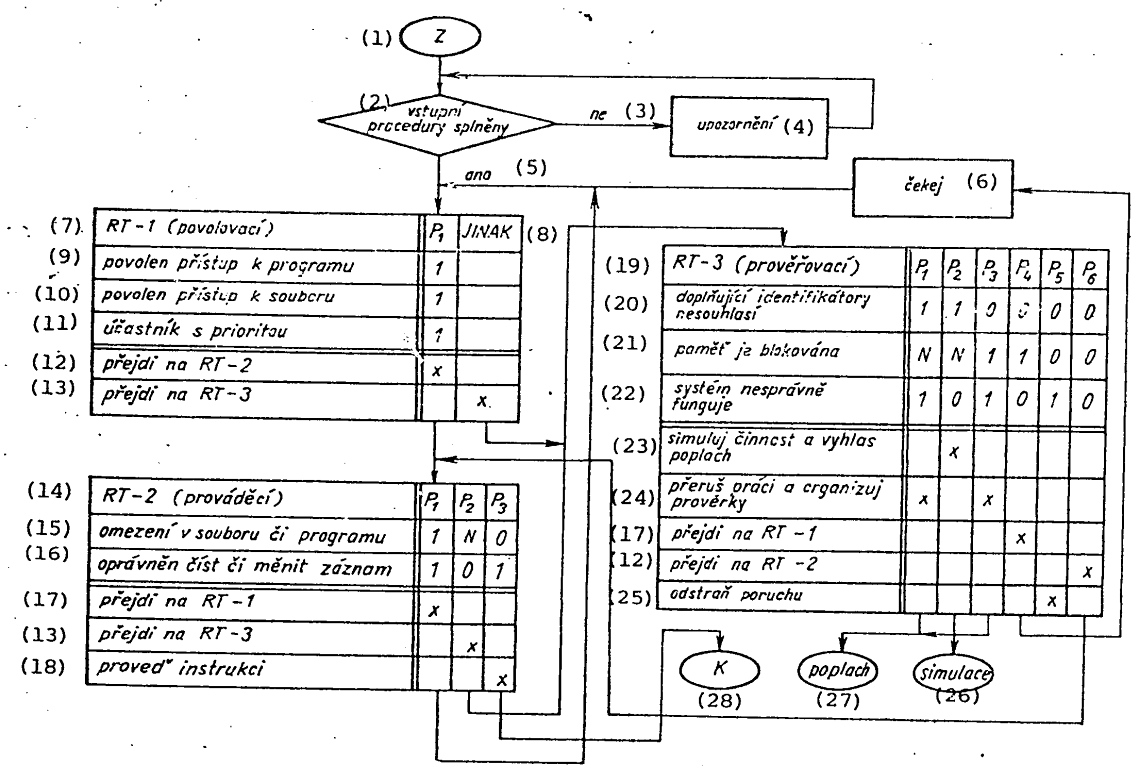

Figure 1. Flowchart of the decision algorithm for access control.
[For key, see next page.]

Key to Figure 1:

1. Start
2. Access procedures fulfilled
3. No
4. Warning
5. Yes
6. Wait
7. RT-1 (permission)
8. ELSE
9. Authorized access to program
10. Authorized access to set
11. Priority user
12. Switch to RT-2
13. Switch to RT-3
14. RT-2 (execution)
15. Restriction on set or program
16. Authorized to read or alter data
17. Switch to RT-1
18. Execute instruction
19. RT-3 (verification)
20. Additional identifiers do not agree
21. Memory blocked
22. System not functioning properly
23. Simulate operation, issue alarm
24. Interrupt, institute checks
25. Eliminate fault
26. Simulation
27. Alarm
28. Stop

If the user fulfills the accessing procedures, he is allowed access to the system and is checked further. Permission table RT-1 investigates whether he has authorized access to the desired program. The user must thus know the identifier of this program. The identifier is valid for one access only and is changed after each access. It is actually a relative address recorded in the system's central memory as a two-digit number that is automatically printed out for the user if he has been permitted access to the program. The program then selects the appropriate set. The user is again checked whether he has authorized access to the set. The set's identifier contains the following: the set's name, the descriptor of the form of recording, the user's identifier, and the identifier of the medium. If the user passes also this check, the permission table investigates further whether he has any priority, whether he may claim preferential service. If the system has only one user, this test may be omitted. The priority identifier is related to the user's function and is expressed numerically (the lower the number, the higher the function and the priority). If all conditions in Table RT-1 have been met, the user may be served. In this case he is transferred to execution table RT-2. If any of the conditions in RT-1 is not met, the user becomes suspect. He is then transferred to verification table RT-3, which investigates whether there is an attempt at penetration.

Table RT-1 contains the ELSE rule; hence it is nonredundant and complete, and therefore it does not have to be analyzed further.

Let us assume that the user has successfully passed all the tests, has reached table RT-2 and demands service. Before a decision to execute the instruction, it is necessary to determine whether the user is within his privileges for the system. Therefore a check is made whether he has any restrictions regarding the set and the program, and whether he is requesting execution of an instruction for which he is authorized. His rights are expressed by the access identifiers. RT-2 thus checks whether these rights have been exceeded. If the user has not exceeded his rights, the desired instruction is executed and the user is served.

Execution table RT-2 contains two conditions. Hence from formula $p = 2^q$ it follows that the table must contain four rules. These are:

P_1	P_2	P_3	P_4
1	1	0	0
1	0	1	0

Let us subject these rules to logical analysis. According to rule P_1, the user is authorized to read or alter the data, but this authorization is not unlimited. He is restricted in relation to either the program or the set. If the requested instruction is in conflict with his rights, the user is returned to RT-1 and is checked again. If it is established that the user accessed the system but does not have any rights (see rule P_2 and P_4), then he is under suspicion of having stolen some of the identifiers, or that he removed or circumvented protection. He is then regarded as a penetrator and is transferred to verification table RT-3. We see that in this case the first rule has no significant validity. Therefore we may introduce the inconsistent value N and combine rules P_2 and P_4. Then solely rule P_3 leads to the execution of the instruction. According to this rule, the user is under no restriction and is authorized to request the instruction. With the execution of the instruction, the algorithm ends.

Table RT-2 is likewise nonredundant and complete. It contains three rules, each of which results in a different decision. Rule P_2, which contains the inconsistent value N, actually represents two rules: P_2 and P_4.

Verification table RT-3 contains three conditions. Theoretically it thus should have eight rules. In our case, however, inconsistent values N are introduced into two rules, whereby the number of rules is reduced by two.

Let us subject these rules to logical analysis. Rules P_1 and P_3 result in the same decision. A basic condition for both these rules is a third condition. If this condition is fulfilled, then the system has lost control over itself and security of the data is compromised. If to this condition there is added a further fault, then it becomes necessary to issue an alarm (acoustical or optical), to disconnect all users, to interrupt operation and institute checks. Rule P_5 likewise leads to a similar decision. But here the system's improper functioning is not linked to any further fault. In this case there is evidently a technical breakdown that must be corrected without delay.

Interesting is the decision pursuant to rule P_2. In this case the protection system finds, with a high degree of probability, that there is an attempt to penetrate the system. The user either did not know the additional identifiers or acted so clumsily that the protection system classified him as a penetrator. If communication with him were broken off on the basis of this finding, an actual penetrator would immediately recognize that he has been discovered, would strive to conceal his clues and to escape. Therefore in this case a secret alarm is issued. Normal operation is simulated, but the penetrator receives false data. Thereby time is gained to catch the penetrator in the act.

Rule P_4 solves the case when one user must allow another user with higher priority to precede him. According to rule P_6, the result of the check on the user is positive, and the protection system has no objection to providing service for him.

We still have to check whether RT-3 is nonredundant and complete. In this case, however, the situation is not so clear as in the case of decision tables RT-1 and RT-2.

Checking the Decision Table

In the case of complex decision tables we check their nonredundancy and completeness by successively reducing them into elementary decision tables whose completeness and nonredundancy we are able to recognize directly. During the reduction into elementary decision tables it is sufficient to investigate only the quadrant of conditions and the quadrant of rules. We distinguish in all six types of elementary decision tables with the following properties:

1.

	P
Q_1	C

Decision table incomplete.

2.

	P
Q_1	N

Decision table nonredundant and complete.

3.

	P_1	P_2
Q_1	C	C

Decision table incomplete and redundant.

4.

	P_1	P_2
Q_1	C	$\bar{C}$

Decision table nonredundant and complete.

5.

	P_1	P_2
Q_1	N	C

Decision table redunandant, possibility of contradiction not excluded.

6.

	P_1	P_2
Q_1	N	N

Decision table redundant, possibility of contradiction not excluded.

The symbols in these tables are as follows:

Q_1, Q_2, Q_3 . . . are the conditions,

P_1, P_2, . . . are the rules.

C . . . is a consistent value of 1 or 0,

$\bar{C}$ . . . is a consistent value of the opposite type, 0 or 1,

N . . . is an inconsistent value of 1 or 0.

The checked decision table is nonredundant and complete if all the elementary decision tables it contains are either of type 2 or type 4. If any other type of elementary decision table occurs, then the checked decision table is either redundant, incomplete or contains rules that lead to contradiction.

Let us now reduce our decision table RT-3. We prepare the reduction on the basis of a selected key condition. We strive to choose a condition that does not contain the value N. In our case we select the first condition, Q_1. On the basis of this key condition we reduce the decision table into two partial decision tables, A and B. Table A will comprise the 1 values of key condition Q_1, and table B will comprise the 0 values of key condition Q_1. Thus

A

	P_1	P_2
Q_2	N	N
Q_3	1	0

B

	P_3	P_4	P_5	P_6
Q_2	1	1	0	0
Q_3	1	0	1	0

Partial tables A and B are not elementary tables. Therefore we continue our reduction. For the key condition in both cases we select Q_3. In the same manner we obtain

AA

	P_1
Q_2	N

AB

	P_2
Q_2	N

BA

	P_3	P_5
Q_2	1	0

BB

	P_4	P_6
Q_2	1	0

All these partial tables are elementary tables and cannot be reduced further. Elementary decision tables AA and AB are of type 2, and elementary decision tables BA and BB are of type 4. Table RT-3 does not contain elementary decision tables of any other type. Hence it is nonredundant and complete.

The advantage of the described algorithm for checking decision tables is its simplicity. Reduction and checking can be run on a computer. In the case of complex decision tables containing several hundred rules, the advantage of this method of checking is obvious.

Conclusion

It is the duty of every top official to protect data and information in general. Modern computers of the later generations, the extensive data banks, and particularly the automatic control systems demand that the problem of data protection be solved seriously and with full responsibility at every level of management. This does not apply merely to systems that process data which are state or official secrets. All data, even nonsecret data, are of considerable value to the user. For this reason it is necessary to guard such data with effective and reliably functioning protection systems. Since the storage, processing and retrieval of data in modern systems is highly automated, it is essential that also the protection system function automatically. Hence suitable methods and tools must be sought for this purpose. The article points out that decision tables are very suitable tools for this purpose.

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CZECHOSLOVAKIA

HIGH-QUALITY STEEL FROM OLD JET ENGINES

Prague HUTNIK in Czech No 2, Feb 80 pp 57-60

[Article by Eng Bohdan Irmler, Trinec Iron Works VRSR [Trinec Iron Works of the Great October Socialist Revolution]]

[Text] Discarded jet engines of aircraft made of highest quality construction materials containing Ni,Cr,Al constitute a very valuable raw material for metallurgical plants. But disassembly of discarded jet engines into individual elements is very time consuming and Kovosrot collection centers perform it only to a limited degree.

Originally the TZVRSR used to purchase discarded jet engines together with assorted highly alloyed scrap for remelting in an open-hearth furnace to recover steel of known chemical composition. Following the modification of the remelting technology in an open-hearth furnace to remove phosphorus, the chromium contained in the aircraft engine was burned away which led to a search for a new method of processing aircraft engines. Following remelting in an electric arc furnace (the engine was added to the basic melt) the resulting average chemical composition in percentages was as follows: C=0.61; Mn=1.04; Si=5.43; P=0.049; Cu=1.16; Cr=7.7; Ni=10.15; Mo=0.59; W=0.73; Ti=0.26; Al=11.0.

The high carbon content stems from the rubber components of the aircraft engine. The true Si content will be considerably lower because following the addition of the aircraft engine the furnace slag was completely deprived of oxygen and an unknown quantity of Si was extracted by reduction from the ladle lining. In reality, the phosphorus content is lower; chemical analyses of individual parts of the aircraft engine disclosed that the steel and the alloys used in the construction contained less than 0.035 percent P. The average sulfur content was not determined because of complete desulfurization of the steel bath following the addition of the aircraft engine (0.003 percent S). Also the aluminum eliminated with the slag was considered.

Chemical analysis reveals that it is most advantageous to process discarded aircraft engines by oxidation remelting in the production of CrNi

(Mo) class 17 steel. The direct remelting technology was developed at TZVRSR between 1976 and 1977. Aircraft engines are remelted in an alkaline 12-ton electric-arc furnace equipped with electrohydraulic control. The transformer input is 2.5 MVA.

The first melts were characterized by excessive meltoff of the furnace bottom and walls as a result of the high temperature of the steel bath following oxidation. The bath temperature could not be determined because TZVRSR did not possess a device for measuring bath temperatures around 2,100°C. Fundamental improvement was not achieved until the following technological changes were made:

a. Nickel plate was replaced with nickel oxide in the melt.

b. The steel-bath temperature before oxidation was increased from 1,580-1,600°C to 1,630-1,670°C.

c. Oxidation with oxygen was terminated when the carbon content in the bath dropped to 0.12-0.15 percent.

The first two technological measures were designed to postpone the oxidation of Al and Si dissolved in the steel bath partly into the last melting stage, mainly into the post-heating stage. This resulted in a sharp increase in the temperature of the steel bath at about 1,600°C at which point the temperature of the melt rose by 50°C within 10 minutes.

The third technological measure was based on the experience that, in difference to melts conducted by the standard technology where intensive carbon combustion terminates at a 0.05 to 0.08 percent carbon content in the bath, intensive carbon burnoff is blocked at a content of 0.12 to 0.15 percent carbon in steel. Prolonged oxidation of melts containing aircraft engines results in increased melting loss of Cr, excessive temperature rise of the steel bath and slag and the simultaneous undesirable meltoff of the furnace bottom, walls and lid.

Tests designed to postpone oxidation till the final melting phase in order to make use of the chemical heat of Al and Si dissolved in the bath were unsuccessful. They resulted in high Cr losses (about 3 percent) and high meltoff of the furnace hearth lining.

In view of the high NiO and low alloy and low phosphorus scrap content in the burden which yields melts with a P content lower than 0.035 percent and after oxidation a carbon content of 0.10 to 0.16 percent, aircraft engines are now being remelted exclusively in the production of steel according to CSN (Czechoslovak Norm) 17,251 of chemical composition of at most 0.20 percent C, 1.5 Mn, 2.00 Si, 0.035 P, 0.035 S, 18 to 21 Cr and 8 to 11 percent Ni.

Charging and Melting Technology

Charging is accomplished in two batches which consist of (in kg):

First batch:	low P and Ni scrap	[illegible],000
	heavy high alloy Cr,Ni scrap	3,000
	carbon Fe-Cr	500
Second batch:	discarded aircraft engine	800
	nickel oxide	500
	high-alloy Cr-Ni chips	3,800
Total		11,600

Table I. Change in the Content of Elements During Oxidation

(a) Tavba	(b) Hodnota	Počet taveb (e)	(d) Obsah [%]												
			C_1	C_2	Cr_1	Cr_2	ΔCr	Mn_1	Mn_2	ΔMn	Si_1	Si_2	ΔSi	Ti_1	Al_1**
s letec. motorem (e)	průměr	47	0,292	0,130	13,79	13,28	0,508	0,793	0,502	0,289	0,866	0,209	0,657	0,142	1,204
	min.		0,16	0,09	11,84	11,12	—0,60	0,59	0,33	0,12	0,32	0,08	0,04	0,04	0,55
	rozpětí (g) max.		0,72	0,19	15,44	15,47	3,19	2,05	1,03	1,02	1,22	0,47	0,99	0,23	1,92
bez (f) letec. motoru	průměr	33	0,348	0,099	16,40*	14,61	1,79	0,691	0,370	0,321	0,368	0,091	0,277	0,042	—
	min.		0,18	0,06	13,34	11,95	0,82	0,45	0,27	0,20	0,21	0,05	0,11	0,01	—
	rozpětí max.		0,52	0,14	19,65	17,59	3,05	1,32	0,47	0,76	0,68	0,17	0,57	0,14	—

Key:

a. Melt
b. Value
c. Number of Melts
d. Content (percent)
e. With aircraft engine
f. Without aircraft engine
g. Average, minimum, range, maximum

Comments:

Index 1--content of element in the bath following melting

Index 2--content of element in the bath following oxidation

Delta--difference in the contents of elements in the bath before and after oxidation

*--the high average meltdown chromium content is due to the fact that 22 compared melts out of 33 were originally conducted as reduction remelts, but because the required meltdown content of carbon was exceeded, melting had to be conducted by oxidative remelting

**--in reality the aluminum contents will be lower; due to lack of chemical homogeneity the upper layers of the bath are richer in aluminum. Aluminum determination is not quantitative and is rather difficult and expensive in this type of steel. For these reasons, aluminum content was determined only in the case of 14 melts.

After the first batch has melted by 60 to 70 percent, the aircraft engine is added and heaped with nickel oxide and alloy chips. The first batch must not be completely melted. Following immersion of the aircraft engine into a completely melted bath the aluminum alloys of the aircraft engine flare up and burn intensely. The meltdown slag is not collected; by chemical composition and appearance it exhibits reducing properties. It is oxidized by oxygen when it reaches the steel bath temperature of 1,630 to 1,670°C with the oxidation completed at a 0.12 to 0.15 percent carbon content of the bath. Chromium is not recovered from the slag by reduction (median Cr_2O_3 content in 17 oxidation slag samples is 11.56 percent), the oxidation slag is skimmed off and oxygen removal precipitation is accomplished by 3 kg/t aluminum forged to a pole. New slag forms consisting of lime and fluor spar. The bath is left to cool and is then alloyed by low carbon ferrochrome, nickel plate or recycling scrap. Following dissolution of the added alloys and homogenization of the bath, the slag is skimmed off and alloying of the melt to the desired composition is completed on the basis of chemical analysis.

This technology is characterized by decarbonization of an actual C-Mn-Si-Cr-Ni-Al-Ti melt. The change in the content of individual elements due to oxidation is indicated in Table I. The same table contains, for comparison, values found in comparison melts without the addition of aircraft engines. The comparatively high Al content in the bath before oxidation influences the increase of the meltdown content of Mn, Si and Ti. Heat generation due to Al, Si and Ti combustion at the start of oxidation raises the temperature of the steel bath rapidly to 1,850°C and higher. At these temperatures, carbon burns off before chromium which is supported conclusively by the melting loss of chromium by 0.508 percent.

The Relationships Established

The basic statistical characteristics were calculated by correlation and regression analysis on an IBM 370/148 computer programmed for mathematical-statistical analysis and relationships between selected technological parameters and chromium loss were established. The most important factors affecting chromium loss were found to be the carbon content in the steel bath following oxidation, the chromium content in the bath following meltdown, the temperature of the melt before oxidation and the melting loss of Si during oxidation.

The equation of the regression hypersurface from which the Cr melting loss can be theoretically derived has for a given number of 47 melts (the critical correlation coefficient value is 0.287) the following form:

$$Cr = 4.973 - 12.68\, C_2 + 0.25\, Cr_1 - 0.00404\, T + 0.443\, \Delta Si \qquad (1)$$

where

ΔCr...chromium melting loss during oxidation (percent)

C_2.....carbon content in the bath following oxidation (percent)

Cr_1....chromium content in the bath following melting (percent)

T......bath temperature before oxidation (°C)

ΔSi...silicon melting loss during oxidation (percent)

The calculated coefficient of multiple correlation for the given equation is 0.737; therefore, it can be said that the chromium melting loss can be explained by the given equation by almost 55 percent as indicated by the graph in Figure 1. Very surprising is the finding that during oxidation the chromium melting loss increases with increasing silicon melting loss.

Other important findings established include in addition the relationship between the carbon content and the silicon content in the bath following oxidation. The regression equation found has the following form:

$$C_2 = 0.106 + 0.118\ Si_2; r_{xy} = 0.442 \qquad (2)$$

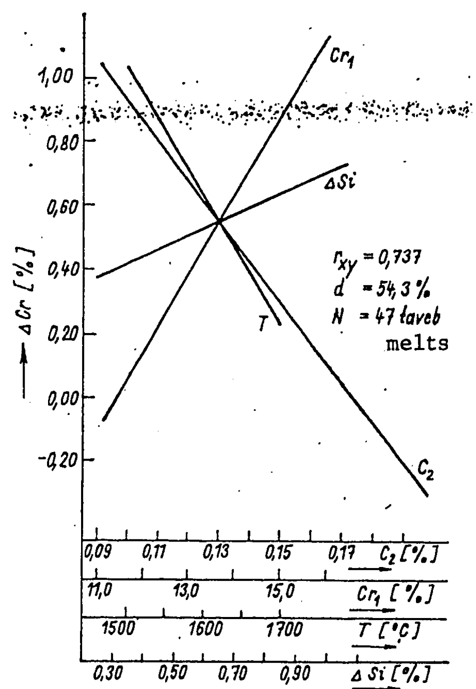

Figure 1. Graphic Representation of Chromium Melting Loss According to Equation (1)

where

C_2....carbon content in the bath following oxidation (percent)

Si_2...silicon content in the bath following oxidation (percent)

The graphic representation is in Figure 2.

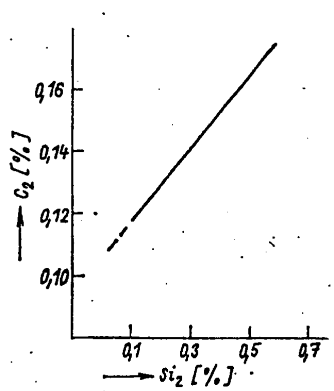

Figure 2. Graphic Representation of the Dependence of the Carbon Content in the Bath Following Meltdown According to Equation (2)

The effect of the aluminum content in the bath before oxidation could not be determined for lack of reliable data, even though it is of overriding importance in the technology under study.

The chemical composition of the slag after the melt and oxidation differs considerably from that of melts conducted according to standard technology as is evident from Table II.

The comparison of analyses of meltdown slags resulting from individual technologies reveals that the content of oxides of elements with lower affinity to oxygen than aluminum is several times lower in melts containing aircraft engines and is replaced by increased content of Al_2O_3 which averages 52.3 percent. The average content of Cr_2O_3 is 2.94 percent compared to 12.1 percent in comparative melts. Oxidation slags in melts with aircraft engines have an FeO,MnO and Cr_2O_3 content two to three times lower than the oxidation slags of the comparison melts and are again replaced by Al_2O_3 and partly by MgO. In both technologies, the CaO contents are on approximately the same level both after meltdown and oxidation. Since the addition of lime to the charge is the same in both technologies, the conclusion can be reached that the weight of the meltdown and oxidation slags is the same in both technologies.

A marked difference exists in the alkalinity of the slags which can be calculated by the simple equation

$$V = \frac{CaO}{SiO_2}$$

and by the expanded equation

$$V = \frac{CaO + MgO}{SiO_2 + Al_2O_3}$$

In view of the high Al_2O_3 content in slags from melts containing aircraft engines, the more correct calculation of alkalinity is derived from the expanded equation. Median alkalinity of slags calculated in this way is 0.551 in melts containing aircraft engines and 0.537 following oxidation which is 2.32 times or 2.33 times lower than in melts not containing aircraft engines.

The Economic Gain

The introduction of direct remelting of aircraft engines in the production of steel in accordance with CSN 17,251 has resulted in considerable saving in ferroalloys, power and in increased output. Compared with the original technology the following savings were achieved:

Reduction in the consumption of	FeSiCr	4.41 kg/y
	FeSi	10.19 kg/t
	MnSi	0.56 kg/t
	Mn aff	1.06 kg/t
	FeCr IV	17.27 kg/t
	FeCr II	25.78 kg/t
	power	110.7 kWh/t
Increased EOP output		0.220 t/h

Conclusion

The electric steel department of the TZVRSR has developed a technology of direct processing of discarded jet aircraft engines by oxidative remelting of high-alloy scrap in steel production according to CSN 17,251 resulting in considerable savings of alloying additives, power consumption and in increased output. The decarbonization of the C-Mn-Si-Cr-Ni-Al-Ti melt with an average content of 1.204 percent Al was tested and introduced in practice. The technology of producing steel in an alkaline furnace using highly acidific slag of median post-oxidation alkalinity of 0.537 at post-oxidation steel temperatures of around 2,100°C was mastered.

Table II. The Chemical Composition of Slag Following Melting and Oxidation

(a) Tavby	(b) Struska	(c) Hodnota	(d) Počet taveb	(e) Obsah [%] FeO	MnO	SiO_2	Al_2O_3	CaO	MgO	Cr_2O_3	TiO_2	NiO	$\frac{CaO}{SiO_2}$	$\frac{CaO + MgO}{SiO_2 + Al_2O_3}$
(f) s letec. motorem	po roztavení (g)	průměr		1,36	0,94	4,11	52,3	24,4	6,62	2,94	2,00	0,137	5,94	0,551
		min.		0,35	0,34	1,85	29,5	15,1	3,50	0,70	0,54	0,012	2,73	0,33
		(i) rozpětí max.	17	2,65	1,48	7,60	64,0	38,9	10.40	4.97	3,50	1,020	16,21	1,61
	po oxidaci (h)	průměr		2,91	2,28	13,24	36,1	10,18	16.32	11.56	2,56	0,30	0.768	0,537
		min.		2,19	1,81	9,8	28,5	7,7	10,7	8,01	1,10	0,019	0,46	0,21
		rozpětí max.	20	3,69	3,29	16.2	42,1	11,5	22,2	18.9	4,70	0,059	0,95	0,77
bez letec. motoru	po roztavení	průměr		3,70	4,09	23.3	6,7	24,0	14,3	12,1			1,032	1,277
		min.		0,82	0,46	13,4	3,5	13,0	9,0	1,0			0,5	0,61
		rozpětí max.	20	6,17	7,58	34,8	11,2	42,8	32,2	25,2			2,3	2,31
	po oxidaci	průměr		0,72	4,82	14,65	3.69	10,59	12.81	37,30			0,702	1,258
		min.		6,28	3,03	8,30	2,12	5,7	7,9	21,8			0,4	0,70
		rozpětí max.	20	13,01	7,28	18,80	5,55	14.1	28,3	45.6			1,0	1,70

Key:

a. Melts
b. Slag
c. Value
d. Number of Melts
e. Content (percent)
f. With aircraft engine, without aircraft
g. Following melting
h. Following oxidation
i. Average, minimum, range, maximum

8664
CSO: 2402

END